SCIENCE

Vol. LXV MARCH 25, 1927 No. 1682

CONTENTS

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 8, 1879.

THE STIMULATION OF RESEARCH IN PURE SCIENCE WHICH HAS RESULTED FROM THE NEEDS OF ENGINEERS AND OF INDUSTRY[1]

THE appreciation of pure science in all civilized countries has steadily increased over an indefinitely long period, but it is quite common to look back to Roger Bacon, or to printing presses, or to Francis Bacon, or to some other definite point whence the start seems to have been made. I doubt if any one time can be chosen over another. The first living cell which made new motions concluded as definitely and acted as consistently as a result of its experiments as we do. We are still infinitely removed from complete appreciation, and therefore not far from the amoeba. The laws illustrated by the amoeba tell us that there are good, bad and indifferent activities, that countless promising experiments may be made, that we may learn after the experiment whether we are better or worse off and finally that the habit of experimenting, or the character of curiosity, may be perpetuated, just as all existing types of plant and animal have been perpetuated.

But to shorten the story I start with Francis Bacon and then proceed at once to the Invisible College of England, about 1645. In 1662 this became the Royal Society for Improving Natural Knowledge, and it has been improving it ever since. Thousands of other groups of scientists and engineers, aiming to advance civilization, have cooperated to the same end. Certainly leading minds long ago recognized research in science as the proper means of human advancement and amelioration.

Gradually in each country accumulating appreciation of knowledge doubtless determined the increasing growth of organized experimental research in schools and universities. This in turn plainly acted on the growing industries, and a closer and closer cooperation became effective. Thus from a time when the monasteries were the schools and students cloistered monks, the old countries became ever more alert to the value of science in human affairs, and college-training put men into service, through the professions or the industries. These in turn still further pro-

[1] Address before the Section of Engineering, American Association for the Advancement of Science, Philadelphia, December 29, 1926.

moted the idea of advancement of learning. Cambridge (England), in my own day, revolutionized pure physical science, and Cambridge (America) enjoyed its first scientist college president.

Strangely enough, it has always resulted that the most remote observations, the most unusual experiments, the most unexpected phenomena, the most insignificant new facts and the most unnecessary discoveries developed into subsequent needs and necessities, but the needs have not usually pointed ahead towards new discoveries. It is becoming more and more clear that the limits of advancement of man are in his own head and hands, and only realized through a process of appreciating nature.

It is a minor, but noteworthy, fact, that in recent years industries in all countries have taken part in scientific work and employed on the whole a rapidly increasing number of engineers and scientists. Interest in new knowledge is no longer confined to the universities. And while it is true that there has been a recognized division of labor such that colleges and universities have usually done pioneer work, and industrial engineers have usually expanded or developed new truths for general appreciation or consumption, it is also true that to-day one may find in the world's scientific literature about as many publications of general scientific value from industrial laboratories, state and private laboratories as from colleges and universities. It is becoming the deliberate habit of industries to support the sciences on which they are based. Perhaps the most marked case in our country, and certainly one which deserves honorable mention, is the telephone company. Its publications are numerous, highly scientific and equal in every way to those of the foremost physical societies. All this betokens a healthy attitude, but no better than we ought to expect from intelligent people who have the history of the past in mind.

I was asked to consider research in pure science with reference to the contributions it receives from industry. I don't intend, in fact I could not, distinguish in that way, though I made an attempt. What I am saying is a natural development of an attempt to divide or locate scientific research either as to quality or source, and I conclude by still more highly appreciating the science of schools and the contributions of engineers and industries.

All research in science seems good to me, and artificial distinctions as to kind and source are invidious. Research will be extended because people see more and more clearly how it works. Pure research is merely uncovering parts of infinite stores whose value, often appreciated, is never anticipated. From my subject you would expect me to deal with pure research and the animation which necessity gives it, but pure science research is not so animated. So I have to clarify the field with definitions, and I accept the recent classification of Balls (*Nature*, August 28, 1926). I will not repeat the eight (a to h) classes, but, beginning with so-called "pure" research, I accept his idea that it is typified by university research, and that it has three degrees of freedom; *i.e.*, freedom in method, aim and subject. Six other classes are defined which carry all the other combinations of freedom and finally class (h) is reached. In this there is *no* degree of freedom, and it is represented by "testing" and "works control laboratory work." Since I accept these definitions I can not attribute pure science research to definite external causes. It is due to internal inquisitiveness of individuals. We may imagine, if we wish, that all scientific work is done because of future needs, but if we use the term "pure science" at all, then we should thank Mr. Balls for classifying the research types, however stimulated. He has given us terms to include all so-called impure and applied research.

Type "a" interests us most. The prime stimulus of this scientific research is curiosity. The most important function of colleges and universities is appreciating inquisitiveness and educating curiosity. There is often a tendency to train men for predetermined mechanical work in which perhaps only the teacher feels the mental stimulus. This is intellectual myopia.

As Mr. Balls gives us eight classes we can probably place any given research in some one of them.

Industry and its engineers call for a great deal of new or more accurate data (classes b to g of Balls). Some of it is splendid material for engineering students. It teaches them careful manipulation and helps introduce them to their chosen fields. But it may be so ill used as to habituate one in seeking only the anticipated object of his forced or hurried work. This makes him bridle or even kill his curiosity, and may train him only as a thoughtless automaton. For example, steel, usually used cold, is now being used hot, and we need strength-tests at high temperatures. Is this research in pure science? It is free in method, but not in subject nor aim. Having that one degree of freedom, it is type "d" of the Balls scale. Under such classification one may suggest that it is the duty of the industry to look out for "d" as it always does for class "h," for example.

A quarter century's experience with existing varieties of research, from pure academic, with three degrees of freedom, to "trouble shooting," with no freedom at all, I see that neither I nor any one else completely comprehends research. This is very fortunate, because we may still learn something about it—by research. I might waste your time by facetiously recognizing only two types, useful and useless. But

there can be no such division in fact. I was asked to point out the stimulation of research in pure science which has resulted from the needs of engineers and of industry. I feel helpless, inquisitive and speculative. Does it work that way? Engineers generally do not want pure research, though they want it to have been done. Perhaps one could *call* this stimulation. They frequently ask for things which are clearly definable but non-existent. For engineering, things must be tangible and contingent. Engineers have pressing problems to solve, and the words "pure research" as a cure for their immediate wants usually connote only postponement or disappointment. Pure research, to be good, is usually random (beyond the edge of knowledge), and is mainly activated inquisitiveness. Engineers never call the products of such research "necessities" until after the engineering event. Every good engineer is too perpetually busy to be much attracted by what is called pure research, however well he may know its laws of birth and heredity. It is productive, but it is not production.

There *is* a stimulation of pure research which doubtless, deep down in the tendencies of research men, is a natural development of the sense for general survival and of amelioration. Most of the so-called pure research that I know about, however, seems to have been at the time as remote from engineering as human effort could make it, and certainly it was not visibly stimulated by recognized needs of engineering. To my mind, engineering is using material knowledge with safety for our convenience. The more knowledge available the better. The more accurate it is, the safer we are. Therefore, whether the individual research man may feel it or not, he is working for future engineers. In that way, pure research is certainly stimulated by engineering.

In geographical discovery there is an obvious parallel. The pioneer, a sport, sportsman or a mere trapper, takes all sorts of risks, travels with difficulty through all kinds of unknown territory, sets various traps or fishes for whatever bites. When he returns to civilization he trades off his catch and his new knowledge. No engineering was in his mind. A real woods pioneer might keep still if he realized that by describing a certain waterfall he was insuring its early development. He would not promote a power site nor a nature-destroying hamlet. But, nevertheless, the pioneer is unconsciously part of the continually growing thing which we call civilization.

The three-degree research man is much like this pioneer. He is usually not weighing the needs of engineers, but rather making the discoveries which interest him. Commercial uses of his discoveries seem often uninteresting, and sometimes even distasteful to him. For example, a pure research man, studying the parasites or the life habits of some lowly insect, makes it possible for an entomological engineer later to save the apple crop of Australia by importing there the enemy of the destructive aphis.

This principle of random research, call it the blind principle, if you will, is evident everywhere—in radio, for example. When crystal sets were the key to receiving stations, engineering needed improvements in efficiency, increases in range and reduction of cost. Engineering refinements of iron filings, cats' whiskers and special synthetic crystals were soon exhausted. But pure research had already disclosed knowledge which made vacuum tubes a promising new territory. Without the random inquisitive research in vacuum phenomena, extending all the way from Edison's early experiments through Thomson, Richardson, Fleming, De Forest, Langmuir and many others, radio might more logically have sought its engineering advances in the saps of trees or in ectoplasm than in a vacuum.

To my mind, the wonderful trait of inquisitiveness in man has thus far kept so much ahead of recognized needs (that is, of engineering) that unapplied assets can still be tapped for further amelioration. As this has been a law from the time when the amoeba first started to move, I think encouraged curiosity is the safest criterion of an improving civilization. If we assumed that man should research only when he felt the need of a definite thing, he would continually butt his empty head against a wall and always the wrong wall.

As J. J. Thomson has said, "Discoveries are not terminals, but avenues." They are not places to stop, but ways to proceed, and the more there are, the more new ones may be opened. The more we subtract from the unknown the greater and more useful it becomes.

Our ancestors who engineered the explored west recognized few of our present needs. Canal boats or ox teams, slowly advancing to fertile lands, were recognized needs, and home-grown food and home-made clothes were necessities. The grandchildren need mile-a-minute transportation, with simultaneous diner and sleeper luxuries. They demand the discoveries in food, raiment, comforts and news from everywhere, integrated over all time. The earlier conception of needs extended to a little faster packet boat, a little heavier oxen, deeper furrows, bigger farms and a longer workday. Similarly, we in our turn blindly think we conceive the needful. Just as changes resulting from curiosity and research have made us forget the needs for canal boats, oxen and even twelve-hour days, so probably our descendants will find more in creation than we do to-day.

Chemical engineers, anticipating needs for liquid

fuels, exhaust the known methods of production. Research chemists, perhaps ignorant of fuels, inquisitively study laboratory curiosities, like catalysis, or they test the correctness of new mathematics, like the Helmholtz and Nernst equations, the Le Chatelier principle, or the kinetic gas theory. They thus store shelves with principles and data which later become indispensable.

An inquisitive engineer, stimulated by the need of change, tries one of these novelties, and soon we hear of synthetic oils and alcohol. The same scientific researches which guide engineering in one such field usually serve many others.

In refrigerating engineering, for example, the history of ammonia, of sulphur dioxide, of methyl chloride or of butane does not disclose stimulation of the engineers' needs. These four avenues proceed ninety degrees apart, and only crossed where the refrigerating engineer happened to read the names of the avenues. Had he been a fertilizer engineer, for example, he might have called new knowledge of ammonia a necessity, but scarcely that of sulphur dioxide.

Engineers are busy with things like buildings, bridges, automobiles, locomotives, subways, power plants, railways, pipe lines and aeroplanes. Each became a necessity only after it had been discovered, reproduced and tested. It wasn't a perfectly obvious thing to build the first bridge. No engineer needed it. A tree fell across a creek and some inquisitive animal shinned over. This first bridge research resembles much of pure research, a kind of monkeying, but it is more useful than aping, as Robinson has pointed out. So also many inquisitive fellows burned their fingers at natural fires long before any one thought of controlling heat or making artificial fires. Some curiosity-seeker later produced hand-made fire, just as inquisitive men, from Nero to Watt, played with steam.

Obviously, it is wrong to overlook the enormous stimulation due to cooperation between research and industry or the mutual relationship of researcher and engineer. I am only contending against the thought that any one can long foresee what may become our major needs and thereby circumscribe pure science research. None of our necessities were planned that way, not even a wheel. Wheels came into engineering, as steam did, through curiosity. Electricity came into engineering after years of accumulated and recorded inquisitiveness, including Faraday's work. Chemistry was the plaything of magicians, monks and pure-science teachers centuries before chemical engineering became a comprehensible term.

As there is no end to new knowledge, so engineering must always grow. Every engineer looks longingly at the properties he employs, to see if they can not be extended, and this leads to endless research of direct utility. But if pure science has any meaning, this is not it. A reason for saying so is that I fear we Americans may grow scientifically near-sighted. We may mistakenly think education the mere recording or measurement of things. The mechanical operations may submerge the mental, and minds be shut in instead of opened out. Transportation was not advanced by breeding fast horses. Trimming sails did not lead to their displacement by steam. The telephone came without improving voices, and radio has come without improving wires. Aeronautics comes more nearly through curiosity over explosions than through feathers. We seem to get ahead by uncovering lightly covered creations rather than by stretching what we know further than it will go.

University-trained men who find themselves in industrial work are not naturally divorced from their earlier scientific associates, nor do they cease to take interest in pure science. Engineering thereby increasingly contributes to science, and industries cooperate with educational institutions. The president of a corporation need be no less interested in pure science than a science teacher. The one may enjoy his method of contribution as well as the other. It would indeed be difficult to differentiate between the cooperate efforts of a Kodak Park or a Nela Park laboratory, as shown by their scientific publications, and an equal volume of pure science publications from colleges. It may be unusual to attribute the same kind of interest in science to the officers of the respective institutions. It exists, however, and indicates the unity of motive which all educated people possess.

We advance more often by finding in nature what we are permitted to use than by making or forcing there what we think we want, so there are the different classes of research. The unhampered, pure science seems best fitted for universities. Though called random research it is neither casual nor accidental. It is the most natural activity of the good teacher in every science. His field is expanding, and he will teach better if he knows its enclosing forests and takes part in their clearing. He needs no better guide than his inquiring mind. The research *engineer*, on the other hand, has some specific aim. Having entered a field already revealed by class "a" research, he plows straight furrows and stops only to remove obstructions. Thereby he also uncovers new knowledge, but he is not free to wander. If gold or coal lies beneath the rock disturbed by his plow, he may find it, but research men, using three degrees of freedom, are more apt to discover there everything but farm products. One aims directly to produce, the other to learn, and both are absolutely necessary to our ad-

vance. There is a natural pressure in competition to encourage the industrial needs, but only an intelligent foresight can insure pure, orderly research, because curiosity is usually restrained. These are generalities, and fortunately every subject and every man is complex. So it is that contributions also come from engineering needs. For example, electrons are discovered, their uses become needs. Pure science research is followed by the seven other classes. Electron emission of tungsten is made useful in radio and the phenomenon of electron emission is studied as broadly and freely as possible. Other elements, like thorium, are thus brought into radio service. The theoretical conceptions and mathematical conclusions are published by men in the industry and the advance of the science and the art accelerated. This process is relatively complete in electrical engineering, but much less so in other research fields. It is clear that every item of new knowledge of electricity can probably be made to do service somewhere. It is relatively a new, compact, orderly, but unlimited field. Research in it would not be so pure, so unattached, so remote as not to fit a use. Close cooperation is to be expected in it between its detached pioneers in colleges and those who plow and reap elsewhere, and a single scientist may do much of each.

Mechanical engineering is in a similar position and chemical engineering is rapidly reaching it. Biology, heredity, psychology, on the other hand—in fact, the greater number of sciences—still lack engineering cooperation. Through pure research there will certainly be continually made other as needful and yet unexpected disclosures as those we now enjoy, and perhaps in entomology, for example, there are more interesting possibilities than were seen in all physics before electricity was pioneered out of it by Faraday.

Bacon said of the Greeks that they had no antiquity of knowledge and no knowledge of antiquity. We see now how well they used what they had. But we ourselves have an accumulation of experimental facts of all kinds which, since the discovery of printing and the establishment of national and international scientific societies, has never ceased expanding. It is upon this stock of tested experience that engineering usually draws. The stimulation responsible for that stock is primarily natural curiosity and must be developed in education. The asset of engineering is exact knowledge. The valuable attributes of research men are conscious ignorance and active curiosity. For an engineer "safety first" is a good slogan, but "safety last" is better for the man of research.

H. E. Armstrong said, "The pursuit of science is necessarily an *anti*-human practice, as it involves an all but impossible self-abnegation." It is more nearly an ante-human practice, as it first discloses to human ken created supplies not otherwise humanly available.

Curiosity may be limited, but creation is unlimited. Free or untrammeled research has given engineering far greater bequests than could be suggested by needs or preconceptions. As this reaction is more in evidence now than ever before, it will continue, and our first interest is to encourage the educated engineering mind. The obvious or pressing needs of industry can be relatively easily and safely cared for as at present.

We ought to realize that there may be a more valuable use of knowledge and truth than commercial developments, and by aiming at the full appreciation of creation we may do more than simply conquer and control our local environment. Perhaps industrial uses of new knowledge are after all only by-products or ways for advancing to something better. As Anatole France said, "The present is being built on the foundation of the wisdom of the past and is destined for the use of the future."

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PHYSIOLOGY AT THE NAPLES STATION

THE most significant effort since the reorganization of the Stazione Zoologica is to be found in the development of the physiological division. Specific leadership, so effective in other departments of the laboratory, was happily provided for in January, 1926, by the appointment of Dr. Sereni as resident physiologist. Since then there has been added to the permanent staff as custodian of apparatus an expert instrument maker whose time is devoted to repairs and renovations of the older equipment; to keeping the new in running order and to such constructions *de novo* as may be called for from time to time by the investigators.

In its historical aspects, this physiological renaissance is not without interest. Among the qualities that made Anton Dohrn a great leader was his ability to foresee. Although a systematist and morphologist by predilection, personal interests did not prevent him from realizing where, in the future, biology was likely to make its most active growth. The very first addition to the original plant was intended to foster the earlier steps in comparative and general physiology. Fourteen years later additional space and facilities for physiology became available by the construction of a wing chiefly for pure and physiological chemistry. The first impression made by the total array of large and small laboratories, private rooms, dark chambers, etc., is well preserved in Boveri's Ge-

dächtnisrede of 1910. Commenting from his own standpoint, Boveri spoke of morphology as "die bescheidnere ältere Schwester," who henceforth "sich wie ein Stiefkind vorkommen könnte."

During the interregnum from 1915 to 1924 development came to a standstill. With the reappointment of Dr. Reinhard Dohrn as director, the station is once more able to command the universal interest and cooperation of former days. The outcome has been a fairly general renewal of foreign tables and especially the vitalizing gifts from the International Education Board. With these funds the entire station has undergone a large part of its much-needed modernization and, as far as possible, has been brought into harmonious relations with present trends and future likelihoods in biology. The process of readjustment, however, has not reached a stage where one may rest content. It is to be hoped that completion in this direction will soon be made possible.

In common with Woods Hole and similar laboratories, the Stazione, except for its widely useful faunistic and ecological studies, has no institutional program of research. On the contrary, it must be prepared to meet the requirements set by the greatest variety of problems. In fields where the simplest equipment suffices, investigators can be provided for with the greatest ease. Even in physiology it is still true that certain individuals can solve certain problems with the aid of a few dishes and the right organism. For other types of work, however, instrumentation, more or less elaborate, is indispensable.

The repertoire of apparatus at Naples shows the advantages of a sound tradition. Minor equipment aside, there have never been any "a priori" accessions; instead the annual budget contains a reserve enabling the institution to adjust itself promptly to specific needs whenever investigators announce them in advance. The more expensive instruments purchased at the behest of individuals nevertheless have always been scrutinized with reference to their more general utility. As a consequence we find at Naples to-day a stock quite adequate in quantity and variety but indicating very discriminative buying.

In a recent announcement intended merely for the general orientation of prospective visitors, three full pages are devoted to major physiological equipment. Included here, often as duplicates or in variant form, are all the usual instruments for graphic registration, electrical stimulation and the measurements of E. M. F. There are seven galvanometers, one after Broca; another, a large string instrument with photographic registration. For students interested in light, there are two spectroscopes and two spectrophotometers, one for microscopic measurement. Among the newer pieces are two thermo-couples, a Weston standard cell, equipment for ultra-filtration, a colorimeter, potentiometer, refractometer, milliamperemeter, thermopile, Hg-rotational interrupter, diverse kymographs, gas-chain apparatus, etc., etc. There has also been installed a small ammonia ice-plant.

To one knowing Woods Hole at first hand all this may appear meager. However, we can avoid misunderstanding if we remember three things. In the first place, the list is not an inventory but merely symptomatic of the sort of provisions that are being made; secondly, nothing is said about the large and varied stock of minor items, chemicals and glassware; and finally, the number of investigators active at Naples at any one time is small compared with the annual swarming at Woods Hole.

Returning from Naples to-day, one is exposed to a series of cross-examinations from those who have worked there in former years. The questions include inquiries regarding the fauna and whether the laboratory is really in running order. The first are easily answered. The density of the marine population is essentially the outcome of two antagonistic elements—the commercial fisheries and the nitrogen supply. Of these, the former fortunately have not been modernized nor noticeably increased; the second is not likely to decrease as long as the cities lining the gulf maintain themselves or continue to grow. Except for seasonal or rarer annual fluctuations in balance, careful attention to the records fails to reveal any movement either in quantity or diversity of the materials hitherto characteristic of the region.

Against the background of history, the question whether the laboratory is indeed running exhibits delicate shades of meaning. Assurance that Naples, in a material sense, can now satisfy the reasonable demands made by students working on problems of the day apparently does not completely reassure. In the past, somehow, the atmosphere pervading the place left a lasting impression on the visitor. It is impossible to say how the "imponderables" of the present compare with those of yesteryear. However, it may be said without fear of contradiction that a subtle and benign influence is easily detectable by any one who is the least sensitive to such things. In thinking over the situation as it is to-day, I recall with pleasure the words of Professor E. B. Wilson. Referring to the reappointment of Dr. Dohrn, Professor Wilson wrote: "No one is so well fitted . . . to keep alive the ideals of Anton Dohrn and to perpetuate the traditions of international scientific fellowship that he upheld in so large and generous a spirit."[1]

OTTO GLASER

AMHERST COLLEGE

[1] SCIENCE, n. s., Vol. 59, pp. 182–183.

THE RELATION OF E. W. SCRIPPS TO SCIENCE[1]

EDWARD W. SCRIPPS was born on a farm near Rushville, Illinois, June 18, 1854, and died at sea on his yacht *Ohio* off the west coast of Africa, March 12, 1926.

Although far from being a scientist in the accepted meaning of that term, Scripps had views about science, an attitude toward it, and did things for it which strongly recommend his career to the attention of scientists.

His curiosity touching everything and everybody round about him was insatiable. His native ability for assimilating facts and principles was astonishing, and the objectiveness of his thinking was naive almost to childishness. I doubt whether any kind or measure of training could have begot in his mind either a trace of doubt as to the reality of sensory experience or of surmise that he ever had experiences which did not contain sensory elements. In that sense metaphysics simply could not exist for him. Add to these characteristics of him the fact that of formal schooling he had almost none, and that by natural bent he was humanistic to the core, and you have the background of his views as to what science is. For him science embraced everything that man knows for a certainty or holds an opinion on supported by the best evidence available. So far as concerns humans as objects of knowledge, it always seemed to me that for Scripps human beings were no more separate from the rest of nature than are stars, mountains and horses. The chiefly distinguishing thing about men was that they were the most curious, most perplexing and most useful of all natural objects. Hence it was that for him the humanistic sciences differed from the other sciences chiefly by their special interest, special importance and special difficulty. His reiterated query, "This damned human animal, what is he?" I have quoted many times to illustrate his peculiar way of recognizing man as a natural being that is especially difficult to investigate.

A phase of his identification of man with nature and his concomitant assumption that man, like the rest of nature, is a subject for scientific study and treatment, was his own common practice of treating human problems quantitatively. While he was very far from being a mathematician in a formal sense, it appeared to be second nature for him to want a quantitative expression for all problems of human relations.

This came out particularly in questions of the growth and support of population, problems in which he latterly became very anxiously interested.

This general quantitative tendency of his was perhaps partly due to the necessity he was constantly under as a business man, of thinking his practical problems in quantities. His calculations were typically of the roughest sort, hardly better than second or third approximations. But they served the purpose of bringing his problems into broad and general, but, in so far, entirely trustworthy view. When greater accuracy became necessary for the practical working out of the problems, somebody could be called in who had more learning, more skill, more time and more patience, for such details.

One consequence of these ideas of his about man and nature and science was his enormous belief in science as an instrument for human welfare. I have often said that I never knew a professional scientist whose faith of this sort was more alive and confiding than was that of Mr. Scripps. "Why, of course everything anybody can learn by investigating the ocean and the organisms that live in it will be useful to somebody in some way at some time." Thus he reasoned while contributing money and thought to the up-building of what is now the Scripps Institution of Oceanography. And so on as to knowledge by all realms of nature.

But always true to his learning toward the problems of man, those included under the captions economics and sociology became for him more and more vividly real and urgent as time went on.

In his late years he had great misgivings about the future of mankind, and about our own country especially. At times he seemed to see forces in our industrial, economic and social life that were driving more strongly toward final catastrophe than any counter-forces that could be mustered. But if such counter-forces there be, they must lie, he felt certain, chiefly in the realms of science. Philosophy? O yes; unrestrictedly generalized and abstract thinking may play a useful part. And religion? Undoubtedly a mighty force for possible good.

But the sciences, particularly those of inanimate nature with their handmaiden, invention, have been the chief means by which man, while securing for himself immeasurable benefits, have also brought upon him problems of the gravest, most perplexing kind.

In Scripps's view there is no alternative to the proposition that the means by which man has gained for himself such vast benefits, but in doing this has

[1] Some aspects of Mr. Scripps's life and work in relation to science are treated more adequately than here in "*Science Service* as *One Expression of E. W. Scripps's Philosophy of Life*," published as a pamphlet by Science Service. Copies of this may be had on application to Science Service, 21st and B Sts., Washington, D. C.

unwittingly involved himself in certain difficulties of great seriousness, must be his chief means for delivering himself from these difficulties.

The problem which finally came to harass him most of all was that of the growth, distribution and support of world population. It seemed to him that for our own country at least, the most urgent aspect of this problem was that of effecting an adjustment between the rural population chiefly engaged in satisfying man's primary needs and desires, and the urban population chiefly engaged in satisfying his secondary needs and desires. The Scripps Foundation for Research in Problems of Population at Miami University is the most obvious expression of his interest in this problem.

Without doubt the most definite manifestation of his conception of and belief in science is Science Service, an institution having operative headquarters in Washington, D. C. The purpose of this is the dissemination of the fruits of scientific research among the people generally. For the carrying out of this purpose any available means may be employed except formal school work. But the means chiefly relied upon is the printing press, especially that of the daily newspaper. Science Service is an institution for the education of everybody in science. But at the same time that it is an educational institution it is a business institution—business in the sense that it earns its own living. Although it has a considerable invested capital, the income from this is not used primarily for carrying on its work but for extending its work into new fields and in new ways. The operative theory on which the institute rests is that all service and everything else received shall be paid for, and all service rendered *shall* be charged for. A cardinal dictum of its founder was that "the two worst economic sins are trying to get something for nothing and willingly giving something for nothing."

While the science-disseminating office of Science Service is clear evidence of Scripps's faith in science as an agency for human good, he conceived another function for it which though less obvious is in a sense more indicative of his faith. The office referred to is that of getting more of the spirit and method of science into the management and work of newspapers themselves. He would have the institution not only disseminate to the public scientific knowledge of the world through the newspapers, but he would have it influence the newspapers to become more scientific in all their purposes and efforts. Although he did not express his aim in just this way, I am sure what was in the back of his mind in founding the institution was that it should contribute toward making journalism an applied science. This conclusion I deduce partly from various things he used to say in our conversations, the full import of which he appeared not to see and I surely did not at the time. One of these was to the effect that he was about as much interested in the influence such work as the institution would do, would have, or editors and editorial offices, as he was in disseminating scientific knowledge. He wanted to educate editors and managers as well as the public. Such statements I now couple, as I could not at the time, with his declaration made at the very beginning of his responsible journalistic career in 1878, that "the newspaper should simply present all the facts the editor is capable of obtaining, concerning men and measures, before the bar of the public, and then, after having discharged its duty as a witness, be satisfied to leave the jury in the case—the public—to find the verdicts."

This conception of the news-gathering and news-presenting function of newspapers (which he regarded as the only real reason for their existence) he appeared to be convinced was not fundamentally different from scientific research and publication. His contention that newspapers should be self-contained, *i.e.*, should have no outside political or business connection or interest he held to be one of the main aids, even though a negative one, to treating news thus. But he also recognized the great difficulties involved in the requirement about "all the facts the editor is capable of obtaining."

The long and short of the matter is, as I now see it, Mr. Scripps decided at last that his forty years of journalism had proved that although the newspaper business can be made immensely profitable so far as money is concerned, it can not be brought up to the level of truth and usefulness he had conceived for it throughout his career without bringing to its aid some medium or agency more intrinsically and deeply devoted to truth and usefulness than the papers are, or by their own nature can be. Hence we have Science Service, organized and operated in accordance with its founder's conviction that it may be made an educational instrument of great benefit to the public and likewise a genuine business success, but that this can be done only by keeping its organization and operation chiefly in the hands of scientists.

Wm. E. Ritter,
President Board of Trustees, Science Service

SCIENTIFIC EVENTS

THE ANTI-EVOLUTION BILLS

The present year has brought forth a plentiful crop of bills to suppress the teaching of evolution in state supported institutions of learning. Thus far, none of them has passed. In Missouri, where some apprehension was felt that the anti-evolution bill might be successful, the measure was defeated in the house by a

vote of 82 to 62. A similar bill passed the house in Arkansas by a vote of 50 to 47, but was tabled in the senate by a very large majority. In Oklahoma an anti-evolution bill was stricken from the calendar by a vote of 46 to 30. A vigorous battle was anticipated in North Dakota, but the committee of the house to which the bill was referred unanimously reported it for "indefinite postponement." A drastic anti-evolution measure has failed also in North Carolina. Alabama has an anti-evolution bill, sponsored by a Baptist preacher, but it seems thus far to have failed to enlist much sentiment in its favor, and little anxiety is felt over the possibility of its passage.

The University of Minnesota is putting up a strong fight against the so-called Riley bill. All of the deans and several prominent faculty members have published statements opposing the bill, and a resolution condemning it was passed unanimously in an enthusiastic mass meeting of over five thousand students, who roared their disapproval in no uncertain terms. This was fine. A petition setting forth the reasons for protecting academic freedom by defeating this intolerant measure was signed by thousands of students and sent to the legislature. This body will be left in no doubt now, if it ever was before, concerning the attitude of the scholastic world as to legislative interference with the rights of the teacher.

The anti-evolution bill in California will not pass. It is strongly opposed in the committee on education, and although some fundamentalists in the state are endeavoring to work up sentiment in favor of it there is little to give them encouragement. A few states remain to be heard from.

S. J. Holmes

THE STEVENSON EXPERIMENTAL ARCH DAM

Extensive tests upon the dam at Stevenson Creek, Fresno County, Calif., have been completed according to an announcement by the U. S. Bureau of Standards. Complete sets of deformations, strain and slide measurements have been made for varied loads up to those produced by a head of 60 feet, the height of the crest of the dam. The tests upon the dam have been made at night to eliminate temperature effects as far as possible.

The only signs of failure are two vertical cracks in the center line of the dam, one extending from the lowest point upward some 13 feet, the other from the highest point downward some 19 feet. The top crack opens widest at a head of 45 to 50 feet and at a head of 60 feet returns practically to the same width as when no water is in the reservoir. This crack does not permit water to seep through. Its maximum width is about 0.03 inch, and the lower crack is still smaller.

Cracks formed at the abutment between the dam and the foundation rock a short time after the completion of the dam, presumably because of shrinkage or temperature changes. These cracks were covered with a fillet of mortar in order to facilitate their observation. Very little change has occurred in them.

The work of analyzing the data is now sufficiently advanced to warrant the following conclusions:

1. The load carried due to the horizontal thrust in the horizontal elements (the arch ribs) has been determined for all parts of the dam under the 60-foot head. The load is a maximum about the mid height and decreases to a small amount both at the top and bottom of the dam.

2. The load carried by bending of the horizontal elements has been approximately determined at certain places. The indication is that the greater part of the load lies nearer the vertical center line of the dam.

3. The load carried by the bending of the vertical elements has been partially determined. Evidently near the bottom of the dam practically all the load is carried in this manner. Near the top none of it seems to be so carried, and the vertical elements appear to be supported by the horizontal elements.

A study of the advisability and nature of further tests upon the dam and of increasing the height of the dam is now being made by the engineers in charge.

SESQUICENTENNIAL EXPOSITION AWARDS TO THE U. S. DEPARTMENT OF AGRICULTURE

The executive committee of awards of the Sesquicentennial International Exposition at Philadelphia has awarded the Department of Agriculture a Grand Prize on account of the merit of its collective exhibit at the exposition. Awards on the exhibits of the various bureaus and offices were also announced, as follows:

Bureau of Plant Industry: Medal of honor, for exhibit of the systematic classification of existing crop plant varieties and the introduction, adaptation and improvement of new varieties, including hays and forage. Medal of honor, for showing original research in the day-length requirements of plant life.

Forest Service: Medal of honor, for excellence of exhibit on the wasting and preservation of American forests.

Bureau of Soils: Medal of honor, for display of analyses and classification of typical soils of the United States.

Bureau of Biological Survey: Medal of honor, on exhibit showing the conservation, utilization, and control of wild life.

Bureau of Public Roads: Medal of honor, for his-

torical presentation of the value and service of good roads and road construction.

Weather Bureau: Gold medal, for original designs in meteorological instruments, weather forecasts, and general Weather Bureau equipment.

Bureau of Animal Industry: Gold medal, for exhibit on control of diseases and improvement of livestock.

Bureau of Dairy Industry: Gold medal, for exhibit, showing the progress in American dairying from 1876 to 1926.

Bureau of Chemistry: Gold medal, for illustrations of the application of chemistry on the farm and in the household.

Bureau of Agricultural Economics: Gold medal, for exhibit on grading and standardization of farm products.

Bureau of Home Economics: Gold medal, for presentation of essentials in home economics.

Fixed Nitrogen Research Laboratory: Gold medal, for exhibits showing advances in production of nitrates from the air.

Federal Horticultural Board: Gold medal, for inspection service and enforcing Federal quarantine measures.

Insecticide and Fungicide Board: Gold medal, for exhibit showing regulatory work in composition and preparation of insecticides and fungicides.

Office of Information: Gold medal, for exhibit on the presentation and distribution of agricultural information by bulletins and through the press and the radio services.

Office of Motion Pictures: Gold medal, for educational film service in agricultural extension work.

Bureau of Entomology: Silver medal, for illustrating progress in applied entomology.

Office of Agricultural Instruction: Silver medal, for presentation of the manner of service in teaching agriculture.

Office of Experiment Stations: Honorable mention, for presentation of experiment-station work.

Office of Cooperative Extension Work: Honorable mention, for exhibit of the cooperative service rendered to aid farmers.

A medal of honor was awarded the Office of Exhibits for effective methods in the presentation of subjects of agricultural interest.

ASSETS AND EXPENDITURES OF HARVARD UNIVERSITY

According to the annual report of the treasurer of Harvard University the assets of the university for the year 1925–26, not including the land and buildings, total $86,540,286.

Of the assets, $11,088,287.10 is listed under the heading of "special investments," and includes most of the donations given to the university for specified purposes. Under the listing "general investments" is the sum of $61,118,731.80.

According to a letter preceding the report, written by Charles Francis Adams, treasurer of the corporation, the net income from all Harvard investments averaged 5.5 per cent. for the year.

The sum of $8,153,931 was expended last year in the maintenance of the various departments of the university. The largest single expenditure on the list was on Harvard College and the Graduate School of Arts and Sciences, $1,681,308.79.

Listed below are the amounts expended by the various schools and departments of the university during the year:

University administration	$ 377,234.59
College, including Graduate School of Arts and Sciences	1,681,308.79
Library	258,815.43
Summer School of Arts and Sciences and of Education	81,864.11
Science and physical education	41,860.82
Schools of Architecture and Landscape Architecture	86,155.36
Graduate School of Business Administration	513,095.84
Bussey Institution	49,216.01
Dental School	125,611.14
Graduate School of Education	165,490.28
Engineering School	242,947.87
Law School	334,849.56
Medical School	675,943.89
Medical School on courses for graduates	44,231.02
Medical School, heat and power plant	209,343.03
School of Public Health	189,959.69
Collis P. Huntington Memorial Hospital	140,194.66
Theological School in Harvard University	72,154.60
Appleton Chapel	19,474.46
Arnold Arboretum	84,137.93
Blue Hill Meteorological Observatory	11,813.26
Botanic Garden	14,752.96
Botanical Museum	5,788.75
Phillips Brooks House	11,220.23
Fogg Art Museum	94,516.12
Germanic Museum	7,616.19
Gray Herbarium	20,894.00
Harvard Biological Institute in Cuba	10,626.11
Harvard Forest	17,046.62
Museum of Comparative Zoology	60,311.46
Observatory	68,100.02
Peabody Museum	28,748.70
Semitic Museum	3,341.53
Stillman Infirmary	56,478.44
Care of grounds	25,410.31
Harvard dining halls	231,409.70
Harvard Union	182,534.09

Committee on the Regulation of Athletic Sports	714,849.02
Dormitories	515,890.35
Non-departmental	278,220.40
Awards to students	400,354.52
Total	$8,153,931.86

PROGRAM OF THE ANNUAL MEETING OF THE AMERICAN INSTITUTE OF CHEMISTS

THE program for the annual meeting of the American Institute of Chemists, to be held at Yale University on March 28, has been announced by Professor Treat B. Johnson, president of the institute, and indicates that virtually every phase of relations between the chemist and his employer will be considered. The meeting will be held from 1:30 to 5:00 P. M., in the Sterling chemistry laboratory, while a public meeting will be held in Woolsey Hall in the evening, at which the chief speaker will be William H. Jardine, United States Secretary of Agriculture.

The afternoon meeting will open with a symposium on "Chemists' Contracts." Dr. L. V. Redman, of the Bakelite Corporation, of Bloomfield, N. J., will discuss the general subject of contracts with employees from the standpoint of the employer. This will be followed by a paper by Dr. William M. Grosvenor, consulting chemist of New York City, and Lloyd Van Doren, also of New York City, on "Chemists' Employment Contracts." Professor Arthur L. Corbin, of the Yale School of Law, will then read a paper on "The Underlying Principles of Employment Contracts." Following the three prepared papers, the symposium will be thrown open for general discussion from the floor. This session promises to be one of the important features of the symposium, and several speakers of prominence have volunteered to cooperate by leading in the open discussion.

Professor Johnson stated that this is the first sincere attempt to be made in the United States to advance in a public way the status of the chemist as a professional worker. One way in which this can be done is to have established the proper legal relationships between the employer and employee. He pointed out that the chemist to-day is like an inventor, and that if he contributes something which is valuable to the employer and community, he is entitled to more than his salary for his services.

The members of the institute will meet at a banquet to be held in the president's reception room in memorial hall of Yale University, at which Dr. C. H. Herty, adviser to the Chemical Foundation, New York City, will be toastmaster.

At the session in Woolsey Hall at 8:15, Professor Henry Solon Graves, provost of Yale University, will preside. Secretary Jardine is to speak on "Agriculture and Modern Science," and will tell of recent developments in chemistry and their relation to agriculture, and describe the work being done in the U. S. Bureau of Chemistry. Before Secretary Jardine speaks, announcement will be made of the name of the recipient of the American Institute of Chemists' Gold Medal for the year 1927. The exercises will be broadcast through Station WTIC, of Hartford, Conn.

SCIENTIFIC NOTES AND NEWS

CHARLES TATE REGAN, F.R.S., has been appointed director of the natural history department of the British Museum, in succession to Sir Sidney Harmer, who retired on March 9. Dr. William Thomas Calman, F.R.S., has been appointed to succeed Mr. Regan as keeper of zoology.

ON January 1 of this year, as has already been noted here, Professor E. J. Baillaud retired from the directorship of the Paris Observatory at the age of seventy-eight. The astrophysical observatory at Meudon near Paris has been combined with the Paris Observatory and Dr. Deslandres, director of the former, is now in charge of both institutions.

THE William Wood Gerhard gold medal of the Philadelphia Pathological Society will be awarded on April 21, at the annual conversational meeting of the society, to Dr. Theobald Smith, director of the department of animal pathology of the Rockefeller Institute for Medical Research. Dr. Smith will deliver the annual lecture on that date, the title being: "The Passing of Disease from one Generation to another and the Processes tending to counteract it." The Gerhard medal of the Philadelphia Pathological Society was established in 1925 to be given as an award for eminent work in pathology.

DR. L. O. HOWARD has been elected honorary member of the New York Entomological Society in recognition of his many and great services to entomology, especially as chief of the bureau of entomology of the U. S. Department of Agriculture.

ON the occasion of the eightieth birthday of Father John George Hagen, director of the Vatican Observatory and formerly of Georgetown University, Pope Pius personally presented him with a specially cast gold medal.

ON February 8 Pennsylvania State College conferred the technical degree of engineer of mines upon David J. Price, engineer in charge of development work in the U. S. Bureau of Chemistry, in recognition of his technical accomplishments in engineering.

THE prize of the value of $250 for the best paper on scientific instruments published during the calendar

year 1926 in the *Journal* of the Optical Society of America and *Review* of Scientific Instruments has been awarded to Professor Horatio B. Williams, Dalton professor of physiology at the College of Physicians and Surgeons, New York City, for his paper on "The Einthoven String Galvanometer," which appeared in the September issue of the *Journal*. Honorable mention was made of the paper by Mr. Leo Behr on "A New Relative Humidity Recorder," which appeared in the June (1926) number. The committee of award consisted of Professor S. R. Williams, Amherst College, *chairman;* Dr. Albert W. Hull, of the General Electric Research Laboratory, Schenectady, and Professor W. G. Cady, of Wesleyan University.

DR. G. E. COGHILL has been added to the editorial board of the *Journal of Comparative Neurology,* which has been reorganized as follows: C. Judson Herrick, University of Chicago, *chairman;* Henry H. Donaldson, the Wistar Institute; J. B. Johnston, University of Minnesota; Adolf Meyer, the Johns Hopkins Hospital; Oliver S. Strong, Columbia University; G. E. Coghill, the Wistar Institute, *managing editor*. Papers may be submitted to any of the editors; proofs and all business correspondence should be addressed to the Wistar Institute, Philadelphia, Penna.

ROBERT J. FORMAD, formerly instructor in histology in the University of Pennsylvania, is now working as a specialist in rabies in the U. S. Bureau of Animal Industry.

C. L. MCARTHUR, chief technologist for the F. X. Baumert Co., Inc., cheese manufacturers, has joined the staff of Arthur D. Little, Inc., of Cambridge, Mass. Mr. McArthur was formerly head of the department of bacteriology of the University of Arkansas.

ROBERT W. HENRY, formerly of the Mellon Institute, Pittsburgh, Pa., has resigned as research chemist for the Gulf Refining Co., at Port Arthur, Texas, to accept a position in the research laboratory of the Marland Refining Co., Okla.

W. O. HOWARTH, lecturer in botany at the University of Manchester, has been appointed to supervise research in mycology under the scheme of the British Empire Cotton Growing Corporation. Mr. H. G. Chippindale has been appointed research assistant in mycology under the same scheme.

THE trustees of the British Museum have appointed Dr. W. D. Lang, assistant keeper in the department of geology, to a deputy keepership in the same department.

PROFESSOR J. FRANCK, director of the Second Physical Institute, University of Göttingen, has accepted a lectureship in physics and chemistry at the University of California for the month of February or March, 1928. Professor Franck will lecture on problems connected with his own researches and will be available for conferences with members of the staff and research students in the departments of physics and chemistry.

DR. SELIG BRODETSKY, professor of applied mathematics at the University of Leeds, recently arrived in the United States to make a tour of the country in the interest of the University of Jerusalem, of which he is one of the governors.

DR. ROY CHAPMAN ANDREWS, of the American Museum of Natural History, sailed from Seattle on March 15, en route to the Gobi Desert in China, where further explorations are planned.

WM. H. ADOLPH, of the department of chemistry of Chee-Loo University, Tsinan, Shantung, China, is on leave in the United States, and during the spring will be located at Yale University.

DR. EDGAR T. WHERRY, of the U. S. Bureau of Chemistry, will be the official representative of the American Association for the Advancement of Science at the approaching meeting of the Virginia Academy of Science, to be held at Blacksburg, Va., May 6 and 7. He will give an address on "Visits to the Haunts of Virginia's Rare and Endemic Plants."

DR. WILLIAM CROCKER, director of the Boyce Thompson Institute for Plant Research, Yonkers, New York, gave two lectures at Pennsylvania State College on March 15; one before the ootany seminar on "Plant Propagation," and one before the local chapter of the A. A. A. S. on "Equipment and Organization for Plant Research."

ON March 5, P. H. Dorsett, agricultural explorer, U. S. Bureau of Plant Industry, delivered an address to the Royal Canadian Institute on the subject "Plant Hunting in North China."

DR. VICTOR C. VAUGHAN, formerly dean of the medical school at the University of Michigan, will give the principal address at the spring meeting of the American Chemical Society, which meets in Richmond from April 11 to 14.

ON February 12, Dr. R. W. Chaney, of the Carnegie Institution, gave a lecture on the botanical results of the third Mongolia expedition at the annual meeting of the California Botanical Society in Berkeley. Professor J. H. Priestley, of Leeds University, England, discussed the advantages of provincial botanical societies and Professor Geo. J. Peirce, of Stanford Uni-

versity, talked on the growth of organisms in saturated brines.

PROFESSOR CHARLES P. BERKEY, of Columbia University, addressed the Swarthmore College Chapter of the Society of the Sigma Xi on "Explorations of the Central Asiatic Expedition in the Gobi Desert," on March 15.

PROFESSOR M. I. PUPIN, of Columbia University, recently gave an informal talk to the physical science teachers and students of Amherst College on the subpect of "Long Distance Telephony."

DR. H. M. AMI, director of the Canadian School of Pre-history in France, recently lectured before the science faculties of McGill University on some of the results obtained during the excavations in the Dordogne District in 1926.

THE Croonian lectures of the Royal College of Physicians will be given in June by Sir F. Gowland Hopkins, professor of biochemistry in the University of Cambridge, on "The Task of Biochemistry."

DR. VICTOR HENRI, professor of physical chemistry at the University of Zurich, addressed the scientific staff of the Rockefeller Institute for Medical Research on March 18 on "Quantitative Researches on Biological Actions of Ultraviolet Rays."

DR. ARCHIBALD VIVIAN HILL, F.R.S., Foulerton research professor of physiology in the University of London, lectured before the Yale Medical Society, on March 16, on "Some Recent Advances in the Physiology of Muscle and Nerve."

DR. H. A. LORENTZ, professor of physics at the University of Leiden, Holland, will address the Franklin Institute on March 31, his subject being "How does an Atom radiate Light?"

LEHIGH UNIVERSITY celebrated the memory of Sir Isaac Newton, the bicentenary of whose death occurred on March 20, by a lecture to which the faculty and students and a few outside guests were invited. The lecture was given by Dr. Paul R. Heyl, physicist at the U. S. Bureau of Standards, on the subject "The Student of Nature."

THE 954th meeting of the Philosophical Society of Washington was held in the Cosmos Club on March 19. The program was in commemoration of the 200th anniversary of the death of Sir Isaac Newton. Frederick E. Brasch spoke on "The Life of Sir Isaac Newton and his Contemporaries"; Edgar W. Woolard on "The Place of Sir Isaac Newton in the History of Pure Mathematics"; T. B. Brown on "The Contributions of Newton to Optics," and Paul R. Heyl on "The Contributions of Newton to Mechanics and to Astronomy."

CLARENCE E. REID, professor of electrical engineering and head of the electrical engineering department of the Kansas State Agricultural College since 1914, died on February 28.

MISS MARY ELIZABETH HOLMES, professor of chemistry at Connecticut College, died on March 12.

DR. HENRY R. CURME, president of Savell, Sayer & Co., Niagara Falls, N. Y., manufacturers of chemicals, was killed by an explosion of a tank of carbon monoxide in the plant yard on March 16. Dr. Curme, who until recently was a fellow of the Mellon Institute, was thirty-two years of age.

EDWIN SWIFT BALCH, of Philadelphia, known for his contributions to geography, died on March 15, aged seventy-five years.

DR. A. W. CROSSLEY, F.R.S., who recently resigned the post of director of the British Cotton Industry Research Association's Shirley Institute, at Didsbury, England, died on March 5, at the age of fifty-eight years.

THE 145th regular meeting of the American Physical Society will be held in Washington, at the National Academy Building, on Friday and Saturday, April 22 and 23. Other meetings for the current season will take place as follows: June 22 to 25, 1927, Pacific Coast section at Reno, Nevada; November 25 to 26, 1927, Chicago; December 27 to 30, 1927, Nashville, Tenn., annual meeting.

PROFESSOR H. E. WALTER, of Brown University, will be in charge of the course in field zoology at the Biological Laboratory at Cold Spring Harbor, Long Island, this summer. Among the new appointments to the staff of the laboratory are Professors A. L. Melander, of the City College of New York, in field zoology; H. S. Conard, of Grinnell College, in plant ecology; J. H. Bodine, of the University of Pennsylvania, in physiology; William Salant, of the University of Georgia Medical School, in research; H. P. K. Agersborg, of the James Millikin University, and Herbert Friedmann, of Brown University, in field zoology, and Mr. Herbert L. Ratcliffe, of the Johns Hopkins University, who will be in charge of chemical supplies. Dr. W. W. Swingle, of the University of Iowa, will be in charge of endocrinology and Dr. J. S. Nicholas, of Yale University, will give a course on experimental surgery in mammals and other vertebrates.

AT the University of Texas, during the spring term of the present year, a course will be given in petroleum geology, participated in by the following geologists: Charles Laurence Baker, "Geology of the Petroleum Fields of Mexico," March 19 to 25; J. W.

Beede, "Petroleum Production from the Permian Formations of West Texas," March 26 to April 8; F. B. Plummer, "Petroleum Production from the Pennsylvanian Formations of Texas and Origin of Petroleum," April 9 to 22; Alexander Deussen, "Petroleum Production from the Salt Domes of the Gulf Coastal Plain," April 23 to 29; Donald C. Barton, "Geophysical Methods, Foreign Salt Domes and Organization of Applied Geology," April 30 to May 13, and W. M. Wrather, "Petroleum Production in the Mid-Continent Fields of the United States," May 14 to 27.

THE ninety-fifth annual meeting of the British Medical Association will be held in Edinburgh from July 15 to 23. According to the provisional program printed in *Nature,* the incoming president, Sir Robert Philip, will deliver his address on July 19. Throughout the meeting the annual exhibition of surgical appliances, foods, drugs and books will be open for inspection. The honorary local general secretary of the annual meeting is Dr. A. Fergus Hewat, 14 Chester Street, Edinburgh. A Lister centenary celebration is also being arranged at Edinburgh in July in connection with the meeting. Throughout the week, a museum of Lister relics will be on view in the upper library of the old university. On July 20 a public meeting will be held, presided over by Lord Balfour, and Sir Watson Cheyne, Professor T. Tuffier (Paris), Professor Harvey Cushing (Harvard University) and Professor James Stewart (Dalhousie University, Halifax, Nova Scotia) will deliver addresses. Inscriptions are to be placed on the walls of 11 Rutland Street and 9 Charlotte Square, both of which were occupied by Lister while in Edinburgh, and a prize of £25 and a gold medal is offered for an essay on "The Influence of Lister on Surgery," the competition being limited to first-year students of medical schools of the British Empire. A Lister memorial volume, edited by Dr. Logan Turner, is in preparation; in addition to personal reminiscences of Lister, it will contain chapters on surgery before and after Lister by Mr. Alexander Miles and Professor Fraser, respectively, while Sir E. Sharpey-Schafer will deal with Lister's work as a physiologist.

DR. ELLIOTT C. CUTLER, Western Reserve University School of Medicine, gave the third Lewis Linn McArthur lecture of the Billings Foundation before the Institute of Medicine, of Chicago, on February 25 on "Postoperative Abscess of the Lung: Experimental and Clinical Studies." According to the *Journal* of the American Medical Association, the former lectures of the Billings Foundation were delivered by Drs. Robert Emmett Farr, of the University of Minnesota, Minneapolis, and Evarts A. Graham, Washington University School of Medicine, St. Louis. The institute will hold a joint meeting with the Chicago Gynecological Society, April 11; Dr. Herbert M. Evans, University of California Medical School, will speak on "Relation of Nutrition to Fertility"; Edward A. Doisy, Ph.D., St. Louis University School of Medicine, "The Ovarian Hormone: Biochemical Studies," and Edgar Allen, Ph.D., University of Missouri School of Medicine, "The Ovarian Hormone: Morphological and Physiological Studies." There will be a joint meeting with the Chicago Medical Society and the Chicago Tuberculosis Society, April 13; Dr. Allen K. Krause, the Johns Hopkins University Medical School, Baltimore, will present the program. The April 22 meeting of the institute will be devoted to the presentation of work by Chicago investigators. There will be a joint meeting of the Society of Medical History of Chicago and the Institute of Medicine, March 18, 8 p. m., at the City Club; Dr. David J. Davis will give an illustrated lecture on "The Quakers in Medicine"; Chauncey Leake, Madison, Wis., will give an illustrated lecture on "Medical Caricature in the United States"; Dr. Richard Dewey, San Francisco, Calif., on "The Care of the Insane in Illinois," and Dr. Benjamin Barker Beeson, "Jean Martin Charcot: A Summary of His Life and Works."

THE bureau of economic geology of the University of Texas and the West Texas Geological Society arranged a conference and excursion into the Glass Mountains of Texas on February 26 and 27. The party of geologists assembled at Alpine on the afternoon of February 25 and disbanded at Fort Stockton on the night of February 27. On the first day exposures were examined in the east and central part of the Glass Mountains, while on the second day exposures were studied at the west end of the mountains and on the Stockton Plateau. Conferences were held at Alpine on the evenings of February 25 and 26. One hundred and fifteen geologists participated, chiefly from Texas, including, however, some from New Mexico and Oklahoma. Details of arrangements for the excursion were in charge of a committee of the West Texas Geological Society, of which Edgar Kraus was chairman. Topographic maps obtained from the United States Geological Survey were supplied complimentary by the Kirby Petroleum Company. A guide map giving the areal geology and localities to be visited was distributed through the courtesy of the Atlantic Oil Producing Company and the Dixie Oil Company. Guides for the excursion for the Permian were P. B. King and W. G. Blanchard, and for the Cretaceous, W. S. Adkins. During the two days, selected exposures were examined representing the formations of the unequaled section of the Permian of the Glass Mountains, totaling some 6,000 feet of sediments, as well as some exposures of the Pennsylvanian and Cretaceous. Ideal weather contributed to the

pleasure of a very successful and profitable excursion and conference. A similar excursion into the Delaware and Guadalupe mountains of Texas and New Mexico will be given probably in May.

THE new Chemical and Metallurgical Laboratory of the United States Naval Station, Cavite, Philippine Islands, was officially opened on March 1, with Francis W. Glaze in charge. Although there had formerly been a laboratory at the Olongapo Station, this laboratory had been connected with the ordnance depot. This is the first time that this naval district has had a laboratory at the service of the district as a whole and operating under the supply department. The location is more or less ideal as far as light and ventilation are concerned. The building was an old, substantial one, with cement floors, and was well adapted for laboratory purposes.

ACCORDING to *Museum News* construction has begun on a $900,000 unit of the new museum building for the University of Michigan, at Ann Arbor. It is expected that this unit, which is about one third of the entire structure as now planned, will be completed by January 10, 1928. The finished building will be in the form of an irregular rectangle, two sides of which are included in the first unit. A feature of the building is the separation of the exhibition and laboratory space in different wings. The laboratory wing extends east and west, most of the laboratories being arranged on the north side. The aquaria and storerooms are for the most part on the south side of this wing. The laboratories will be equipped in accordance with the best modern practice, for the teaching of science.

ONE of the largest private collections of ferns in the world, contained in the herbarium of Dr. E. D. Copeland, has been deposited in the herbarium of the University of California, through the efforts of Dean E. D. Merrill, of the College of Agriculture. The collection, comprising some 12,000 specimens of ferns, many of them from old collections and of great historical value, will be available for use and reference at the university. Dr. Copeland is spending several weeks in Berkeley classifying the specimens and getting the herbarium into useful shape.

UNIVERSITY AND EDUCATIONAL NOTES

THE new chemistry building of the University of Richmond will be dedicated on April 11 during the spring meeting of the American Chemical Society in Richmond. Drs. Charles H. Herty and E. Emmet Reid will be the principal speakers at the ceremonies. After the dedication opportunity will be afforded everyone to inspect the new plant and the exhibition of industrial products to be displayed.

THE University of Rochester is perfecting plans for the construction of a new chemistry building. It will be three-story and basement, estimated to cost close to $250,000, with equipment.

A NEW chemical engineering laboratory is to be built at the Iowa State College, Ames. The building, for which contracts have been let, will be 100 by 72 feet and will be devoted exclusively to teaching research work in chemical engineering.

DR. JAMES KENDALL, professor of chemistry in New York University, has been appointed dean of the graduate school of the university, succeeding Dean Earle Brownell Babcock, who resigned recently after two years' leave of absence as European representative of the Carnegie Endowment for International Peace.

DR. W. C. BOWER, professor of electrical engineering at Northwestern University, has been appointed director of the school of engineering in the university.

MRS. THEODORE BOVERI, wife of the Italian biologist and organizer of the biological laboratory at Vassar College, has accepted the chair of biology at Albertus Magnus College, the new Catholic college for women in New Haven, and will come to this country next fall to organize the department.

DUE to the vacancy caused by the recent death of Dr. Albert W. Smith, late head of the department of chemical engineering, President Charles S. Howe, of the Case School of Applied Science, has appointed Dr. William Reed Veazey, professor of physical chemistry, acting head of this department.

DR. CHARLES A. DICKINSON has been appointed professor of psychology at the University of Maine.

ASSISTANT PROFESSOR F. S. NOWLAN, of the University of Manitoba, has been appointed professor of mathematics at the University of British Columbia.

M. MASSON, professor of pathological anatomy at the University of Strasbourg, has been appointed to a position in the University of Montreal.

PROFESSOR VON BERGMANN, of Frankfort, has accepted a call to the University of Berlin to succeed Professor F. Kraus in the chair of internal medicine.

DISCUSSION AND CORRESPONDENCE

HELIUM

A SUGGESTION in the use of helium for diving is that, on account of the cost of helium, the divers' atmosphere consisting of oxygen mixed with helium

and which gradually loses its oxygen by breathing and accumulates impurities, such as carbonic acid gas, shall be returned in a closed cycle for purification and restoration of its original composition. Gas filters would be used to take out impurities and effete gases, and new oxygen would be supplied in accordance with the advisability discoverable by gas tests, so that the same helium could be used over and over again for a great length of time without any considerable loss. In the same way, in a caisson, where the space is considerable, filters can be mounted within the caisson, through which the atmosphere can be circulated, filtering out the effete gases and impurities, and perhaps reducing the moisture by drying and returning the same to the caisson; while it is perfectly easy in this case to replenish oxygen by oxygen in pressure tanks or by using dioxide of barium or dioxide of sodium, to obtain any desired enrichment with oxygen to take the place of that which has been consumed. All of this can be put under automatic control, even within the caisson itself. An air-lock could also be constructed for saving as much as possible the helium from diffusion and loss when such lock is operated. Helium being a light gas, the exit from the air-lock should be in a downward direction and not upward. In other words, the trap door, as it were, should open outward in the air space in the form of a depending syphon, so that the helium necessarily escaping into the air-lock could be pumped out and recovered.

ELIHU THOMSON

LYNN, MASS.

BALL DANCING ON WATER-JET

A NOTE in *Science Abstracts* for January, 1927, reminds me that in the issue of SCIENCE for August 13, 1926, Mr. W. C. Baker discussed "The Retention of a Ball by a Vertical Water-Jet," reaching the conclusion that the "law of Bernoulli," sometimes referred to in this connection, has little if anything to do with the matter.

I reached a similar conclusion many years ago, writing in the *Youth's Companion*, probably about 1902. On page 166 of my "Elements of Physics," published in 1912, is a figure with the legend "Action and Reaction due to Adhesion," and the accompanying text reads substantially as follows: "If a spool carried on a flexible horizontal support is made to touch one side of a slender vertical jet of water, adhesion of the spool to the water deflects the stream, making it turn partly around [and above] the spool. The reaction for this action is a pulling of the spool toward and into the stream, so that it is presently hit on its under side by the rising water and is accordingly lifted. This phenomenon suggests an explanation of the fact that a small ball of cork or wood may be supported for a considerable time, perhaps many minutes, in such a jet of water as that just described, without falling out at the side."

The spool was carried by a rod on which it was free to turn, and it did turn briskly as the stream of water wound about it. The shape of the stream, drawn out into a thin web at the place of parting from the spool, plainly showed the action of adhesion. To allow sidewise motion of the spool the rod supporting it was carried by a piece of clock-spring.

EDWIN H. HALL

CAMBRIDGE, MASS.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

THE secretary of the International Commission on Zoological Nomenclature has the honor to announce the publication of Opinions 91 to 97 (rendered by the International Commission on Zoological Nomenclature) by the Smithsonian Institution in Smithsonian Miscellaneous Collections, volume 73, number 4, pages 1 to 30. The summaries read as follows:

OPINION 91. Thirty-five generic names of mammals placed in the official list of generic names: The following names are hereby placed in the official list of names: *Alces, Arvicola, Ateles, Bison, Bradypus, Canis, Capra, Cebus, Cervus, Choloepus, Condylura, Cricetus, Crocidura, Cystophora, Dasyprocta, Didelphis, Erethizon, Felis, Gulo, Halichoerus, Lepus, Lynx, Mus, Myrmecophaga, Nasua, Ovibos, Phyllostomus, Procyon, Putorius, Rangifer, Rhinolophus, Rupicapra, Sciurus, Sorex, Vespertilio.*

OPINION 92. Sixteen generic names of *Pisces, Amphibia* and *Reptilia* placed in the official list of generic names: The following names are hereby placed in the official list of generic names: PISCES: *Blennius, Echeneis, Esox, Ophidion.* AMPHIBIA: *Cryptobranchus, Desmognathus, Siren.* REPTILIA: *Alligator, Calamaria, Chelydra, Crotalus, Dermochelys, Eremias, Lacerta, Mabuya, Phrynosoma.*

OPINION 93. Twelve generic names of fishes placed in the official list, by suspension of the rules: The following twelve generic names of fishes are herewith placed in the official list of generic names, under the plenary power for suspension of the rules: *Conger* Cuv., 1817 (*Muraena conger* L.); *Coregonus* Linn., 1758 (*Salmo lavaretus* L.); *Eleotris* Bloch & Schneider, 1801 (*gyrinus* Cuv. & Val.); *Epinephelus* Bloch, 1792 (*marginalis* Bloch); *Gymnothorax* Bloch, 1795 (*reticularis* Bloch); *Malapterurus* Lacépède, 1803 (*Silurus electricus* L.); *Mustelus* Linck, 1790 (*Squalus mustelus* L. [=*Mustelus laevis*]); *Polynemus*

Linn., 1758 (*paradisaeus* L.); *Sciaena* Linn., 1758 (*umbra* L. = *Cheilodipterus aquila* Lacép. as restr. by Cuvier, 1815); *Serranus* Cuv. (*Perca cabrilla* L.); *Stolephorus* Lacép., 1803 (*commersonianus* Lacép.); *Teuthis* Linn., 1766 (*javus* L.).

Names now current are not to be discarded unless the reasons for change show a clear-cut necessity.

OPINION 94. Twenty-two mollusk and tunicate names placed in the official list of generic names: The following names are hereby placed in the official list of generic names: MOLLUSCA: *Anodonta, Argonauta, Buccinum, Calyptraea, Columbella, Dentalium, Helix, Limax, Mactra, Mya, Mytilus, Ostrea, Physa, Sepia, Sphaerium, Succinea, Teredo.* TUNICATA: *Botryllus, Clavelina, Diazona, Distaplia, Molgula.*

OPINION 95. Two generic names of *Protozoa* placed in the official list of generic names: The following names are hereby placed in the official list of generic names—PROTOZOA: *Endamoeba, Trypanosoma.*

OPINION 96. Museum Boltenianum: The commission accepts the Museum Boltenianum 1798 as nomenclatorially available under the international rules.

OPINION 97. Did Hübner's Tentamen, 1806, create monotypic genera?—Hübner's Tentamen, 1806, was obviously prepared essentially as a manifolded manuscript, or as a proof sheet (cf. Opinion 87), for examination and opinion by a restricted group of experts, *i.e.*, in *Lepidoptera,* and not for general distribution as a record in Zoology. Accordingly, the conclusion that it was published in 1806 is subject to debate. Even if the premise be admitted that it was published in 1806, the point is debatable whether the contained binomials should be construed as generic plus specific names. Even if it be admitted that the binomials represent combinations of generic plus specific names, they are essentially *nomina nuda* (as of the date in question) since authors who do not possess esoteric information in regard to them are unable definitely to interpret them without reference to later literature. If published with more definite data at later dates, these names have their status in regard to availability as of their date of such republication.

C. W. STILES, *Secretary*

U. S. PUBLIC HEALTH SERVICE

PROFESSOR BARUS AND COLLOID CHEMISTRY

On reading over a paper entitled "Remarks on Colloidal Silver" published by that sterling investigator Carl Barus, of Brown University, in the *American Journal of Science* for December, 1894 (Vol. 47, p. 451–4), I am struck by the remarkable manner in which in so small a space he has foreshadowed so many of the subsequent developments of colloid chemistry. Thus aggregation and dispersion methods and the colloidal zone are well indicated in the following:

"Suppose a solid is dropped into an excess of its solvent. In order that the system may become a solution, the disaggregation must at least reach the molecule. In electrolytes it may go further as is evidenced by Arrhenius's celebrated factor 2. But, under other circumstances, may not the separation stop short *before* the molecule is reached; or conversely, may not the process of growth be arrested in virtue of an equilibrium of when a precipitate is being formed out of individual molecules forces when the particles formed consist of 2, 10, 100, or even 1000 molecules? To answer affirmatively is to find a home for the family of colloidals, and they will more nearly resemble solutions in proportion as the particles are smaller. Certainly the beam of light is no longer an available criterion, for the whole phenomenon is mapped out on a scale which is small even in comparison with the wave length of light."

His experiments on ultrafiltration are thus referred to:

"In the endeavor to pass compressed air through a wet porous porcelain septum into water, I was struck by the magnitude of the pressures necessary. Supposing I waited long enough to insure the transpiration of liquid, no flow of gas through the septum occurred for pressures of even in excess of 100 lbs., excepting at isolated points which were obviously the seat of fissures . . . [the superior limit of] $r = 18 \times 10^{-6}$ cm nearly, making the diameter ($2r$) of the pores smaller than the wave length of violet light. Schneider showed however that colloidal silver passes readily through such a septum whereas the alcoholic precipitate fails to do so. The particles are therefore respectively smaller and larger than the diameter given. If 10^{-8} cm be taken as the order of molecular dimensions, the size in question is at least 1,000 times as large, showing the aggregates to consist of the enormous number of 10^9 molecules at least. There is thus an abundance of room for particles containing (say) 100 molecules to the aggregate, and forming suspensions in water (colloids) in their general aspects hardly distinguishable from true solutions."

It is interesting to ask how great a pressure would force the water out of a septum just large enough to let the particles of the size in question (5×10^{-8} cm) pass. It would take several thousand atmospheres, and it is therefore quite impossible to test finer septa like animal membrane to the extent in question. Nevertheless if the attempt be made to *grade* porous clay septa, prepared by successive vitrifications, by the method given, I dare say that a range of mean

diameters of pores could be obtained, sufficient to answer many outstanding dimensional questions in relation to the colloidal state; but one should be prepared to exert pressures as high as 100 atmospheres."

He speaks of "the metallic optics of colloidal silver" as "a field of great promise" and one "to be looked to for decisive results, not only for silver but for other colloids." Zsigmondy's discovery of the ultramicroscope about five years later, brilliantly confirmed this prognostication.

The gradual dominance of chemical forces with increasing subdivision appears in the concluding paragraph:

"Of the two interpretations which may be given Carey Lea's brilliant discovery, the one originally advocated by Dr. Schneider and myself is to me intensely the more interesting. As an aggregate of excessively fine suspended particles, colloidal silver introduces a whole series of fascinating physical problems, subject to forces which as to their nature are almost tangible. Even in an ordinary case of sedimentation if I write

Muddy water + acid = acidulated water + mud,

the later body being precipitated, I have a chemical equation in embryo—an equation which so far as can now be discerned lacks stoichiometric precision, but which in its general character is undoubtedly a double decomposition. If the actuating forces be traced, they must lead by slow gradations up to affinity."

It will be a real service to science if Brown University will collect and publish the widely scattered papers of her emeritus professor of physics, as was done in Belgium with the work of Walther Spring, and by the University of Toronto with the work of Professor Wilson Taylor.

Jerome Alexander

SYSTEMIC EFFECTS FOLLOWING THE STING OF A SPECIES OF EPYRIS

For the past three years reports have come to me from a family living on a more or less isolated delta farm in Clarksburg, California, regarding the activities of a tiny wasp which has become a pest because of its readiness to sting.

Before describing the disturbances caused by the sting, it might be well to state that, through the kindness of Dr. Frank Lutz, the wasp was identified by S. A. Rohwer as belonging to the genus Epyris and represents a species near *clarmontis* Kieffer. The wasps belonging to this genus are, as a rule, parasitic on lepidopterous larvae.

There are five members in the family, namely, the parents who are forty years of age and the children aged four, six and eight years. The parents are unusually intelligent and both college graduates and they are fully aware that only by accurate observations could any conclusions be drawn.

The wasps appear in fairly great numbers in the fall after a warm spell and invade the house where they get into the bedding and clothing, and sting when brushed or crushed by clothing or sheets against the skin, and only one instance is recorded where stinging occurred when apparently unprovoked. The sting is distinctly felt as a fairly sharp prick, decidedly less intense than a bee sting, but sufficiently so to make the youngest child cry. In every member is there a definite local reaction, namely, redness and swelling. In the oldest and youngest child no further manifestations occur, but in the parents and second child a decided systemic disturbance follows.

A few minutes after being stung, there is felt a numbness, often at the site of the sting, but at other times beginning at the finger tips. It remains localized for a few minutes and then gradually spreads and involves the entire body. In the mother there is an intense itching of the vulva and in the father an itching of the pubes. This is followed by a marked diarrhœa, not painful in the father, but resembling severe uterine cramps in the mother. The diarrhœa and cramps last for about ten minutes. The mother, who is an asthmatic, experiences no respiratory difficulty, but in the father who has never had an attack of asthma wheezing occurs occasionally. Accompanying these symptoms there is marked prostration, weakness and sweating. The duration of the attack is about half an hour. The second child becomes drowsy and is awakened with difficulty and wheezing occurs. He also recovers in about the same time as the parents.

On one occasion the father was bitten while visiting a neighboring camp and the effect was so severe that he was forced to lie down utterly helpless.

In the fall of 1926 there was a greater invasion of these wasps than usual and stinging was almost a daily occurrence. So bad were the effects that moving was contemplated.

It would be of considerable interest to know of similar reports. Unfortunately the attacks are of comparatively short duration and I have never witnessed the distressing effects. I am also unable to find any similar history among the neighbors, although they complain of the stings of these insects, but not the systemic disturbances.

There is little question in my mind, however, that the severe disturbances are caused by the stinging of these wasps. This conclusion is drawn on the following, namely, the experience of three years occurring only in the fall when the invasion of insects takes place, the finding of the insect shortly after

stinging occurs, and the invariable similarity of the attacks.

CHAS. E. VON GELDERN, M.D.

SACRAMENTO, CALIF.

SCIENTIFIC BOOKS

Three Centuries of Chemistry, Phases in the Growth of a Science. By IRVINE MASSON, D.Sc., F.I.C., professor of chemistry and head of the department of pure science, The University of Durham. The Macmillan Company, New York, 1926, 191 pages, 1 plate.

OF the recent histories of chemistry which have come to the reviewer's notice, the present work is one of the most stimulating and inspiring. The volume is not a complete history, even for the three centuries which it is supposed to cover, the author having "chosen to portray the genesis and evolution of ideas rather than to rehearse every discovery that gains a place in our chemical text-books." Very little information, for example, is given concerning the rise and development of organic chemistry, these phases of the subject being regarded by the author as of too specialized a character for the non-technical reader. Professor Masson's book, therefore, should not be read as a mine of information, but rather for its suggestiveness and the inspiration which it arouses to pursue further the history of a great department of science.

In Part I, upon "The Rise of Scientific Thought," the author after a brief introduction discusses the work of Sir Francis Bacon and its influence in establishing the Philosophical or Invisible College of London about the beginning of 1645. From this club of scientists there afterwards emerged the Royal Society which Professor Masson regards as the *fons et origo* of a considerable part of subsequent scientific developments. He mentions in this connection the stimulating influence of Boyle and others of the Royal Society upon their fellow member, John Winthrop, Jr., the founder of chemistry in the English Colonies of North America. The letters written to the Royal Society by Winthrop, Leonard Hoar, William Avery and others are of particular interest to American readers, for they show that the efforts of the society "to season the youth of New England with its experimental philosophy" had begun to bear fruit.

In Part II upon "The Genesis of Modern Chemistry" the influence of Boyle "the father of chemistry" is traced. This section of the book is most delightful reading, for fine scholarship is intermingled with warm human interests. It is the most accurate and appreciative evaluation of the work of Boyle that has yet been published and deserves to be read again and again.

In Part III upon "The Search for the Elements" five interesting chapters are devoted to the work of Mayow, Hales, Hooke and other English chemists upon combustion, to the growth of the phlogiston hypothesis under Stahl, to the development of the use of the balance under Black, to the investigation of gases by Cavendish and Priestley, and to the final overthrow of the conceptions of the four elements and of phlogiston by Lavoisier. In this section Professor Masson gives well-balanced accounts of the work of these chemists with brief references to their influences and personalities. In commenting upon the inheritance of scientific knowledge, on page 96, he traces Mayow's experiment of burning a candle in a jar inverted over water back to Sir Francis Bacon. He might have followed this path of transmission to a much earlier date, for the experiment is recorded in a Latin translation (*De Ingeniis Spiritualibus*) of the "Pneumatica" of Philo of Byzantium who lived in the second century B. C.

In Part IV upon "The Search for the Structural Units," the final section of his book, Professor Masson traces the development of the ideas of the molecule, atom and ion. This is the least satisfactory part of an otherwise most successful volume, for the treatment is one which appeals neither to the chemist nor to the non-technical reader. The effort to crowd the chemical developments of the past 125 years into a small compass of forty pages is an impossible task under almost any plan of curtailment. Part IV of "Three Centuries of Chemistry" is in consequence a fragment with little of the humanistic atmosphere which gives so much of quality and charm to the earlier pages. The postscript upon Professional Chemistry, which Professor Masson has added to his book, is an essay that will appeal more to teachers of chemistry than to the general reader.

"Three Centuries of Chemistry" leaves the reader with the unsatisfied feeling of a person who has had his appetite whetted for more. One wishes that Professor Masson might have included many more of the personal sketches which he has drawn so vividly in the case of Bacon, Black, Cavendish, Hartlib, Hooke, Mayow, Petty, Priestley, Wallis, Wilkins and Wren. These pen pictures are almost epigrammatic in brevity, yet they convey clean-cut impressions, so that the reader is in no doubt as to the character and personality of the men described. Hooke, for example, is portrayed as "a hollow-cheeked, sallow, wry-bodied little man; a 'fretful porpentine,' far too ready to stick a quill into any one whom he suspected of impinging on his own discoveries; very jealous for his own credit, in that uncomfortably assertive way sometimes seen in an unprepossessing person with a good brain." The reader not only sees the man but actually knows him.

The book is provided with a good index of persons and subjects. The frontispiece is an interesting old astronomical plate, with figures of Copernicus, Galileo and Kepler, reproduced from the fifth edition of John Wilkins's "Discourse Concerning a New World and Another Planet." The volume is printed on heavy paper, almost like cardboard—a little too inflexible for convenient turning of the pages. It is cordially recommended not only to all chemists but to every student of the history of science.

C. A. BROWNE

Die Vitamine, Kritische Uebersicht der Lehre von den Ergänzungsstoffen. VON RAGNER BERG, leiter des physiologisch-chemischen Laboratoriums auf Weisser Hirsch. (Germany.) Zweite, umgearbeitete Auflage. S. Hirzel, Leipzig, 1927. pp. 714, with subject index, author index and a bibliography of 3,500 titles.

THIS monograph is an able and useful treatise on *nutrition,* with special reference to the vitamines. It is much more than a manual on the vitamines. For example, we have comprehensive and critical chapters on the biological value of the different proteins, on mineral metabolism, on diet as related to growth, on nutritional edema and on pellagra, in addition to shorter sections on sprue, on "Mehlnährschaden" and on "Milchnährschaden." In the chapter on beri-beri and the various forms of polyneuritis the author gives a full and fair account of the data and views of the Japanese investigators who claim that human beriberi is a different, or at least a more complicated, disease than the acute polyneuritis induced in animals by vitamine B free diets. The work of Evans, Sure and others on the so-called fertility vitamine (E) is reviewed in the chapter on "Growth," but Berg does not recognize this work as having demonstrated a new vitamine.

The final chapter includes an extensive table showing the distribution of the vitamines in foods. Here the author deviates from the usage in English nutrition literature in designating the antiarchitic vitamine as "E." In English and American nutrition literature this vitamine is usually given the letter "D," while "E" is being applied to the fertility vitamine of Evans and Sure. This is an unfortunate confusion.

The author is critical, catholic and fair in the treatment of the extensive literature. In the preface he extends special thanks to American investigators for sending him reprints and monographs in the vitamine field. The monograph ranks with the best on the subject.

A. J. CARLSON

UNIVERSITY OF CHICAGO

SPECIAL ARTICLES

A PRELIMINARY REPORT ON THE STUDY OF THE EMISSION SPECTRA AND SURFACE TENSION ALTERATIONS IN EXPERIMENTAL ANIMAL TUMORS[1]

IN the Emery Laboratory of Experimental Radiology and Roentgenology an earnest effort has been made to study, from the physical and physical-chemical point of view, the initial alterations undergone when a cell is transformed from a state of normality to one of malignancy, and the resulting physical-chemical and biological changes accompanying such manifestations. A portion of the work, that already completed, has proved fruitful and has been reported on numerous occasions by one of the writers and shall not be included in this preliminary announcement which deals entirely with our studies of spectrum analysis and surface tensions.

Knowing the physical nature and modus operandi of the various spontaneous and induced radiations at our disposal, we feel that the true action of radium and roentgen therapy must be accurately studied and controlled to bring about a scientific treatment of the most dreaded disease which the medical and allied professions are called upon to combat.

To the present time, the portion of our researches reported in this communication have been confined almost entirely to the behavior of normal and cancerous tissues which have not been subjected to any form of ray therapy. This is necessary before we are able to study any effect resulting from treatment by radiation.

These investigations have offered results which are of extreme scientific interest and importance.

First, we shall consider the method and scope of our researches in the field of spectroscopy.

All animals used were killed by decapitation to eliminate the possibility of a tissue change due to the prolonged administration of ether anesthesia.

In order that all types of normal tissue occurring in the body might be studied, the heart, peritoneum, lungs, liver and brain from one or more rats were removed, weighed, ignited in a platinum crucible and thoroughly ashed in the flame of a blast lamp. When sufficiently cooled, the sample was again weighed, and the percentage of ash calculated, the ash then being reduced to a homogeneous powder in a chemically clean agate mortar.

In order that each of the organs previously men-

[1] From the Emery Laboratory of Experimental Radiology and Roentgenology, Hahnemann Medical College and Hospital, Philadelphia.

tioned might be studied separately, individual ashes were prepared as just described.

In the preparation of the pathologic ashes, the tumors were removed from the decapitated animals, freed from any undesirable portion and ashed in exactly the same manner as were the normal tissues. A portion of each tumor used was reserved for microscopic verification.

Preliminary work with the spectrograph disclosed a striking difference of intensity of certain lines common to the spectra of the normal and the pathologic ashes, and showed that this difference varied with the time which elapsed between the striking of the arc and the exposure of the plate. To study this variation, and to make the conditions of the experiments as uniform as possible, the following procedure was adopted.

An uncored carbon was drilled with a one-sixteenth inch drill to a uniform depth of three-sixteenth inch. The carbon, so drilled, was placed in a small arc lamp and allowed to burn for three minutes, at the end of which time a spectrogram of the carbon was taken. The hole was then filled with the ash to be tested, the arc struck and a series of exposures made without interrupting the current.

To insure exposures of equal lengths and equal intervals between successive exposures, a pendulum bob was swung between the arc and the slit of the spectrograph, the photographic plate being moved while the light was intercepted by the bob.

Twelve exposures were made on each plate, each exposure being 1.8 seconds, and the interval between exposures 0.2 second.

As the dispersion of the quartz spectrograph used in the above experiments was too small to admit of reliable determinations of wavelengths, recourse was had to a larger instrument. With this, using panchromatic plates, the linear distance between $\lambda = 5300$ and $\lambda = 2900$ A.U. was 16 cm. The distances between the lines were measured with a photomeasuring micrometer, and the wavelengths read from a large dispersion curve plotted with points obtained from the arc lines of copper.

Measurements extended from $\lambda = 2680$ to $\lambda = 4979$ A.U. These values check very closely with the wavelengths of sodium as found in Kayser and Runge tables of wavelengths.

In practically all cases of the normal tissue ash, the sodium lines, which were of feeble intensity in the first exposure, disappeared after the third or fourth exposure; the rest of the spectrum persisted until the ash had been consumed.

With neoplastic tissue ash, the sodium lines in the first exposure were very intense. In most cases, some of the lines of other elements present were very faint, but generally appeared intense in the third or fourth exposure. The intensity of the sodium lines remained constant until all the ash was consumed.

Due to the present limited spectroscopic equipment of the Emery Laboratory, we have been unable, to the present time, to substantiate any other possible variations aside from the excess sodium content of neoplastic tissue, but with increased facilities we hope to be able to detect, by means of further study of the emission spectra, absorption spectra and the spark spectra of the vapors given off during the preparation of the ashes, any and all variations which have occurred during the malignant cell change, and the alterations brought about under the influence of radiation.

Spectrograms of many different normal and pathologic ashes have been made, using for the pathologic ashes many of the known and recognized strains of experimental animal tumors, as well as spontaneous tumors received from the Wistar Institute of Anatomy and Biology. For the normal tissue ashes, all possible variations of rats—sex, age and breed—were employed.

An interesting verification of the above finding was made by titrating with N/100 sulphuric acid solutions made from the normal and neoplastic tissue ashes. The amount of acid found necessary to neutralize the alkali of the neoplastic tissue was more than double that for the normal tissue ash.

For the study of surface tension, tissues from normal rats—tumors and irradiated tumors—were employed, always using a portion of the same tissues which were at the same time prepared for spectrum analysis.

In preparing the material (normal or pathologic tissues) for the surface tension determinations, a weighed amount of tissue was agitated at a uniform rate with ten times its weight of double-distilled water in an alkali-free glass tube and shaking machine, designed and constructed for the purpose.

At the end of thirty minutes shaking, the tube contents are transferred to an alkali-free glass tube, well sealed, and allowed to stand for five minutes.

After the initial separation has taken place, the supernatant liquid is withdrawn and placed in Pyrex glass tubes and centrifuged at a high speed for ten minutes.

The material freed from insoluble particles, is transferred to alkali-free glass containers, sealed, labeled, and is then ready for the tests.

For the determinations the du Noüy surface tension apparatus was employed, the ring being flamed between succesive readings.

Our results obtained from tissues prepared as just described, were as follows:

(1) The dynamic surface tension of solutions of normal tissue is, in general, lower than that of solutions of pathologic tissue (carcinoma and sarcoma) prepared at the same time.

(2) The dynamic surface tension of solutions of both normal and neoplastic tissue kept in closed vessels, in general, increases with time.

(3) The rate of increase is *less* for solutions of normal tissue and tissue which has been radiated than for solutions of untreated neoplastic tissue.

(4) The tension reaches a nearly constant value in one to three weeks (depending upon the nature of the solution) which is slightly (one or two dynes) higher than that of distilled water at the same temperature.

(5) The temperature coefficient of the tension is greater than that of distilled water, being larger for solutions of normal than for solutions of neoplastic tissue.

(6) Upon cooling the solutions to the original temperature, the tension is always lower than at a corresponding temperature on the heating curve, an effect which is more pronounced for solutions of normal tissue.

The above results are consistent with the theory that the value of the dynamic surface tension of a solution of tissues is depressed below that of the solvent (distilled water) by the action of the colloidal particles from the tissue and that these particles undergo transformation with time in such a manner that salts are formed which ultimately cause the tension to be elevated slightly above that of distilled water. Due to the presence of excess salts in the solutions of neoplastic tissue, the tensions of such solutions are higher than those of normal tissue, and their rate of increase is more rapid, since the salts tend to coagulate its protein content of the colloidal material.

DONALD C. A. BUTTS
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AN ATTEMPT TO CORRELATE THE JOULE MAGNETOSTRICTIVE EFFECT AND HYSTERESIS LOSS IN A SERIES OF NICKEL STRIPS

IN a very interesting study of the parallelism of the Joule magnetostrictive effect and the hysteresis loss in nickel as different degrees of tension were applied to the rods, Wwedensky and Simanow[1] found a very striking correlation between the two. This parallelism between magnetostriction and hysteresis loss seems to be borne out by the work of McKeehan and Cioffi,[2] who found that at approximately 81 per cent. of nickel in permalloy no magnetic change in length occurred and also the hysteresis loss was negligible.

In the first paper mentioned, this parallelism was obtained by varying the tension and in the second paper by varying the amount of nickel present.

The author has been studying[3] the magnetic properties of a group of eleven strips of nickel, all cold rolled from the same heat of nickel. These strips were cold rolled to varying thicknesses and thus a series of nickel strips with different degrees of hardness were obtained. If the change in length of these strips for any given field strength and the hysteresis loss are plotted against the hardness values of the same strips, the curves thus obtained ought to show a similarity if the parallelism is a constant for all factors imposed on nickel.

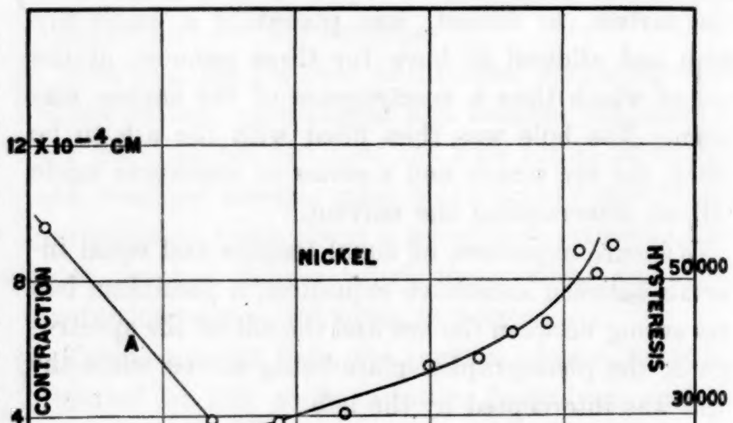

FIG. 1

Curves showing this relation are given in Fig. 1. The values for the changes in length of the various strips were those obtained when a field strength of 57.7 gauss was applied to each one of the specimens of nickel. The same relation would hold for any other field strength. The hysteresis loss per cubic centimeter per cycle is for B_{max} carried to a point of saturation. Curve A presents the relation between the hardness and the contraction of the various strips, while curve B is the corresponding curve for the hysteresis losses.

The results seem to indicate that the hardness factor does not produce a parallelism between hysteresis and magnetostriction.

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[1] Wwedensky and Simanow, *Ztschr. f. Physik*, 38, p. 202, 1926.

[2] McKeehan and Cioffi, *Phys. Rev.*, 28, p. 146, 1926.

[3] Williams, Trans. A. S. S. T., 1926.